Description

Interference suppression device

The invention relates to an interference suppression device for an electronic appliance having a plug device, which has at least one plug element and is arranged on an electrically conductive housing of the electronic appliance, having a printed circuit board, which is arranged in the housing and bears an electrical and/or electronic circuit to which the plug element is connected, and having a capacitor which is connected on the one hand to the plug element and on the other hand to the potential of the housing.

It is known with such interference suppression devices to pass the plug elements of the plug device through cutouts in a plug cover into the housing interior to connect them there to the capacitor and the circuit. Via the cutouts and metal parts, including the plug elements, which protrude into the housing interior from the outside, radio-frequency interference radiation of, in particular, > approximately 400 MHz is conducted and irradiated into the interior of the metal housing, which is actually provided for shielding purposes, and may impair the operation of the circuit of the electronic appliance owing to the high-energy radiation.

One object of the invention is therefore to provide an interference suppression device of the type mentioned initially which, given a simple and cost-effective design, ensures effective shielding against, in particular, radio-frequency interference radiation and is also suitable for mass production.

This object is achieved according to the invention by the capacitor being arranged on the printed circuit

board, one part of which protrudes out of the housing interior through an opening, and likewise extending from the housing interior to the housing exterior, and by the plug element on that part of the

printed circuit board which is located in the housing exterior being conductively connected to the capacitor and the circuit.

This design has the advantage that the interference suppression takes place even on the outside of the electronic appliance and interference radiation does not even reach the housing interior. Such an interference suppression device has few components and can therefore be assembled in a simple and cost-effective manner. In this case, without significant additional complexity, that part of the printed circuit board which extends from the housing interior to the housing exterior forms, together with the housing having ground potential and in a simple manner, a bushing capacitor, each individual plug element being filtered effectively.

Production may be simple if the capacitor comprises a first and a second capacitor face which are arranged opposite one another such that they are separated by an insulating layer, the first capacitor face being electrically conductively connected to the potential of the housing, and the second capacitor face being electrically conductively connected to the circuit. The insulating layer may be formed in a component-saving manner by the printed circuit board.

In order to make contact in a simple manner with the housing, the first capacitor face may be arranged on the surface of the printed circuit board.

Particularly effective shielding is achieved if the printed circuit board has two further capacitor faces, which lie one above the other and which are electrically insulated from one another, for the purpose of forming a further capacitor for the same plug element, the third capacitor face being

electrically connected to the plug element and the fourth capacitor face being electrically connected to the housing potential, it being possible in this case too to make contact in a simple manner with the housing if the fourth capacitor face is arranged on the surface of the printed circuit board.

It goes without saying that, in addition, more than two capacitors may also be provided. For this purpose, the printed circuit boards are preferably multilayer printed circuit boards which may have more than four layers on which the capacitor faces are arranged.

If the first and the fourth capacitor faces are conductively connected to one another by means of plated-through holes which enclose between them the second and the third capacitor faces and preferably extend approximately on the plane of the housing wall, the second and third capacitor faces are surrounded by ground potential, which leads to a reduction in the effective opening cross section and thus to a further increase in the shielding.

For cost-effective production of the capacitor faces, one or more of the capacitor faces may be capacitor coatings on the printed circuit board.

For signal transmission purposes, the plug element(s) or the capacitor faces which are conductively connected to the plug elements are preferably connected to the circuit via signal lines.

In this case, the signal lines can be produced in a simple and cost-effective manner if they are layer lines applied to the printed circuit board.

In order to increase the shielding effect, the opening in the housing preferably tightly encloses the printed circuit board passed through it.

A connection to the ground potential is made in a simple manner and without significant component complexity if the opening region of the housing is in conductive contact with a first and/or fourth capacitor face, which is/are arranged on the surface of the

printed circuit board, of the capacitor.

In this case, no special components are required if the opening region of the housing bears in a resilient manner against the first and/or fourth capacitor face. At the same time, effective closure of the opening is produced.

Mechanically robust contact is made with the ground potential by the opening region of the housing being connected to the first and/or fourth capacitor face by means of a connecting element, in particular by means of a rivet.

The opening region of the housing may also be connected in an interlocking manner to the first and/or fourth capacitor face, it being possible for this to take place in a simple manner by part of the opening region of the housing being inserted in a corresponding cutout in the first and/or fourth capacitor face with a press fit.

Both mechanically robust contact is made with the ground potential and closure of the opening with effective shielding is achieved if the opening region of the housing is conductively connected to the first and/or fourth capacitor face by adhesive bonding or soldering.

A further connection to the ground potential is achieved if the housing is capacitively coupled to the first and/or fourth capacitor face.

In order to further increase the shielding effect, the capacitor and/or the further capacitor may be connected to the circuit via an interference suppression capacitor.

In order to optimize the shielding in the region of the opening further still by reducing the effective opening cross section, the housing wall may have shielding arms lying adjacent to one another

in the region of the opening, in which the shielding arms are short in the regions of the capacitors extending from the housing exterior to the housing interior and rest with their free ends on the first capacitor face, and the shielding arms are long in the regions free of capacitors extending from the housing exterior to the housing interior and extend through through-openings in the printed circuit board until they come to bear with their free ends against a wall part of the housing.

In this case, contact can be made with the ground potential of the housing in a simple manner by the shielding arms bearing on the first capacitor face and the wall of the housing with resilient prestress.

Production may use few components and may be cost-effective if the housing wall is in the form of a stamped/bent part in the region of the opening.

For further shielding purposes, that part of the printed circuit board which is located in the housing exterior and capacitors as well as the plug elements can be arranged in an outer, electrically conductive housing chamber.

Exemplary embodiments of the invention are described in more detail below and are illustrated in the drawing, in which:

figure 1 shows a cross section through a first exemplary embodiment of an interference suppression device,

figure 2 shows a plan view of the printed circuit board of the interference suppression device shown in figure 1,

figure 3 shows the interference suppression device shown in figure 1 with an illustration of the interference radiation,

figure 4 shows a cross section through a second exemplary embodiment of an interference suppression device,

figure 5 shows a cross section through a third exemplary embodiment of an interference suppression device,

figure 6 shows a cross section through a fourth exemplary embodiment of an interference suppression device in the region of a short shielding arm,

figure 7 shows a cross section through the interference suppression device shown in figure 6 in the region of a long shielding arm,

figure 8 shows a plan view of part of the printed circuit board of the interference suppression device shown in figure 6, and

figure 9 shows a perspective view of the housing wall in the region of the opening of the interference suppression device shown in figure 6.

The interference suppression devices illustrated in the figures have a housing 1 made of sheet metal for an electronic appliance, which has an opening 3 at a lateral housing wall 2. A printed circuit board 5, which rests on elevated embossed areas 6 of the base 7 of the housing 1, is arranged in the housing interior 4. The printed circuit board 5 bears an electronic circuit (not shown) with which contact can be made from the outside via plug elements 8, 8′ and which is fed low-frequency signals via the plug elements 8, 8′.

The printed circuit board 5 has a part 9, which extends through the opening 3 to the housing exterior 10, the base 7 of the housing 1 protruding laterally and covering the entire lower region of the printed circuit board 5, including the part 9.

The plug elements 8, 8' have plug pins 11, which

protrude horizontally away from the housing 1 and onto which a corresponding opposing plug pair (not shown) can be plugged. Those ends of the plug elements 8, 8' which are opposite the plug pins 11 protrude vertically through the printed circuit board 5. The plug element 8 is conductively connected to second and third capacitor faces 12 and 13 arranged on the printed circuit board 5, an insulating layer 32 being arranged between the capacitor faces 12 and 13. The second and third capacitor faces 12 and 13 are connected to one another via a connection 14, and are connected to the circuit via an interference suppression capacitor 16 and a signal line 15.

The second and third capacitor faces 12 and 13 in this case extend from the housing exterior 10 through the opening 3 into the housing interior 4. A first capacitor face 18, which forms a capacitor 18 with the second capacitor face 12, is arranged on the upper surface of the printed circuit board 5 such that it lies opposite and parallel to the second capacitor face 12 and such that they are separated by an insulating layer 17.

In the same manner, a fourth capacitor face 21, which forms a further capacitor 22 with the third capacitor face 13, is arranged on the lower surface of the printed circuit board 5 such that it lies opposite and parallel to the third capacitor face 13 and such that they are separated by an insulating layer 20.

The figures show the connection of the capacitors 19 and 22 to a plug element 8. The capacitors associated with the further plug element 8' are located on a sectional plane different to that illustrated.

In exactly the same way as the second and third capacitor faces 12 and 13, the first and fourth

capacitor faces 18 and 21 also extend from the housing exterior 10 through the opening 3 into the housing interior 4. In this case, that part 9 of the printed circuit board 5 which extends through the opening 3 is tightly enclosed by the opening 3 in the housing 1.

In the exemplary embodiments in figures 1, 3, 5, 6 and 7, the fourth capacitor face 21 rests on the embossed area 6 of the base 7 and is thus connected to the ground potential of the housing 1.

In the figures, the first capacitor face 18 is connected to the ground potential of the housing 1 by the housing wall 2 resting on the first capacitor face 18 in the region of the opening 3.

In the exemplary embodiment in figures 1 to 3, the housing wall 2 is made of resilient sheet metal and rests with resilient prestress on a contact region 25 of the first capacitor face 18.

In figure 4, the housing wall 2 is of two-part design in which the housing 1 largely covers the plug elements 8, 8', and said plug elements 8, 8' are surrounded by an inner cover 23 of the housing wall 2 so as to form a housing chamber 24. In this case, the opening 3 is formed at the inner cover 23 which is soldered in the opening region to contact regions of both the first capacitor face 18 and the fourth capacitor face 21.

In the region in which they touch, the housing wall 2 and the inner cover 23 bear against one another in a resilient manner. In the exemplary embodiment in figure 5, a housing chamber 24' is formed by an inner cover 23' in a similar way to that in figure 4. In this case, the inner cover 23' is soldered at its upper end to the inner wall of the housing 1 and at its end which rests in a resilient manner on the contact region of the first capacitor face 18. In the exemplary embodiment in figures 6 to 9, as in figure 5, the housing wall 2 and thus a housing chamber 24'' is formed by an inner cover 23''. This inner cover 23'' in the form of a stamped/bent part made of resilient sheet metal is illustrated as a detail in figure 9 and has at its

upper end a bent-back section 26 with which it is riveted to the upper wall of the housing 1. At its end facing the printed circuit board 5, the inner cover 23'' is formed with shielding arms which lie adjacent to one another and which are alternately short shielding arms 27 and long shielding arms 28.

All of the shielding arms 27 and 28 have a bulge 29 in their central region such that they are resilient in their longitudinal extent.

The short shielding arms 27 rest with the end side of their free end in a resilient manner on the contact region 25' of the first capacitor face 18.

Corresponding to the position of the long shielding arms 28, through-openings 30 are formed in the printed circuit board 5, through which through-openings 30 the long shielding arms 28 protrude and, with the end side of their free ends, bear in a resilient manner against the embossed area 6 of the base 7.

Figures 3 to 7 show, by means of arrows 31, the radio-frequency interference radiation which is prevented from penetrating into the housing interior 4 by the interference suppression device.